canusa

Canada
United States
Spruce Budworms
Program

Newsletter

NUMBER 37, NOVEMBER 1984

The Program Leaders Say Goodbye

This is the final edition of the CANUSA *Newsletter*. Although the *Newsletter* will continue in a revised format, we will not have the same involvement that we had during the life of the Program. On looking over the past issues, we are amazed at the breadth of budworm coverage that is contained in the *Newsletter*. Very few items of interest to the general reader have escaped notice. This is due, of course, to the high level of cooperation we have received from you, the recipients and contributors. Without your support and participation in this, and all the other ventures and projects of the Program, we would have had a very hard time indeed.

The CANUSA Spruce Budworms Program has been the largest international cooperative forestry R, D & A Program ever attempted. We are proud to have been associated with it and especially all the hard-working scientists and constructively critical clients. Your support over the past 7 years has been gratifying, and has made the successes that have emanated from the Program possible. There have been very few activities in the research program that at least one of us has not been closely associated with, and these contacts will be remembered fondly in the years ahead. The planning meetings, working group deliberations, management seminars, symposia, and technology transfer projects continually reminded us of the tremendous spirit of cooperation fostered by CANUSA, and it is our hope that this cooperation will remain as a legacy of budworm and other integrated international research for many years.

To the senior management of the USDA Forest Service and the Canadian Forestry Service, we thank you for providing us with this unique opportunity to serve our respective Services. We also appreciate the support of the Joint Policy and Program Council, the Joint Planning Unit, and the Program Managers and their staffs in developing, approving, and implementing the Program.

We will miss the daily contacts of CANUSA, but take solace in the expectation that the cooperative programs initiated within the Program will be continued.

It looks as if the budworms will continue to be of concern to resource managers for the foreseeable future, and we can expect new and improved management tactics to develop, accelerated we hope, by the CANUSA network of contacts.

We will remember you all fondly. From the standpoint of our personal careers, the most rewarding part of the CANUSA Program was working with all you wonderful people. Thank you for the experiences of the CANUSA togetherness, and we wish you success in your future endeavors.

Mel E. McKnight
Program Leader, USA

Chuck H. Buckner
Program Leader, Canada.

Spruce Budworms Research Symposium at Bangor

The third week of September, just a few days before CANUSA-U.S. terminated operations, the Program welcomed over 200 guests to its final technology transfer effort. Plans for the international research symposium had been in the works for 3 years. When it was over, Mel McKnight and Chuck Buckner were greeted with comments like, "Why didn't we do this sooner?" All of us in the Program management took this as a sign of work well done.

Most attendees arrived on Sunday, the 16th, in time for an icebreaker reception at the Bangor Holiday Inn. Meanwhile, CANUSANs who contributed poster displays were busy across the street at the Bangor Civic Center setting up their handiwork. CANUSA displays filled the lobby of the Civic Center. Black-and-white film cannot do justice to the posters, many of which incorporated color art work. Nearly all were professionally prepared, and it showed (figs. 1–7).

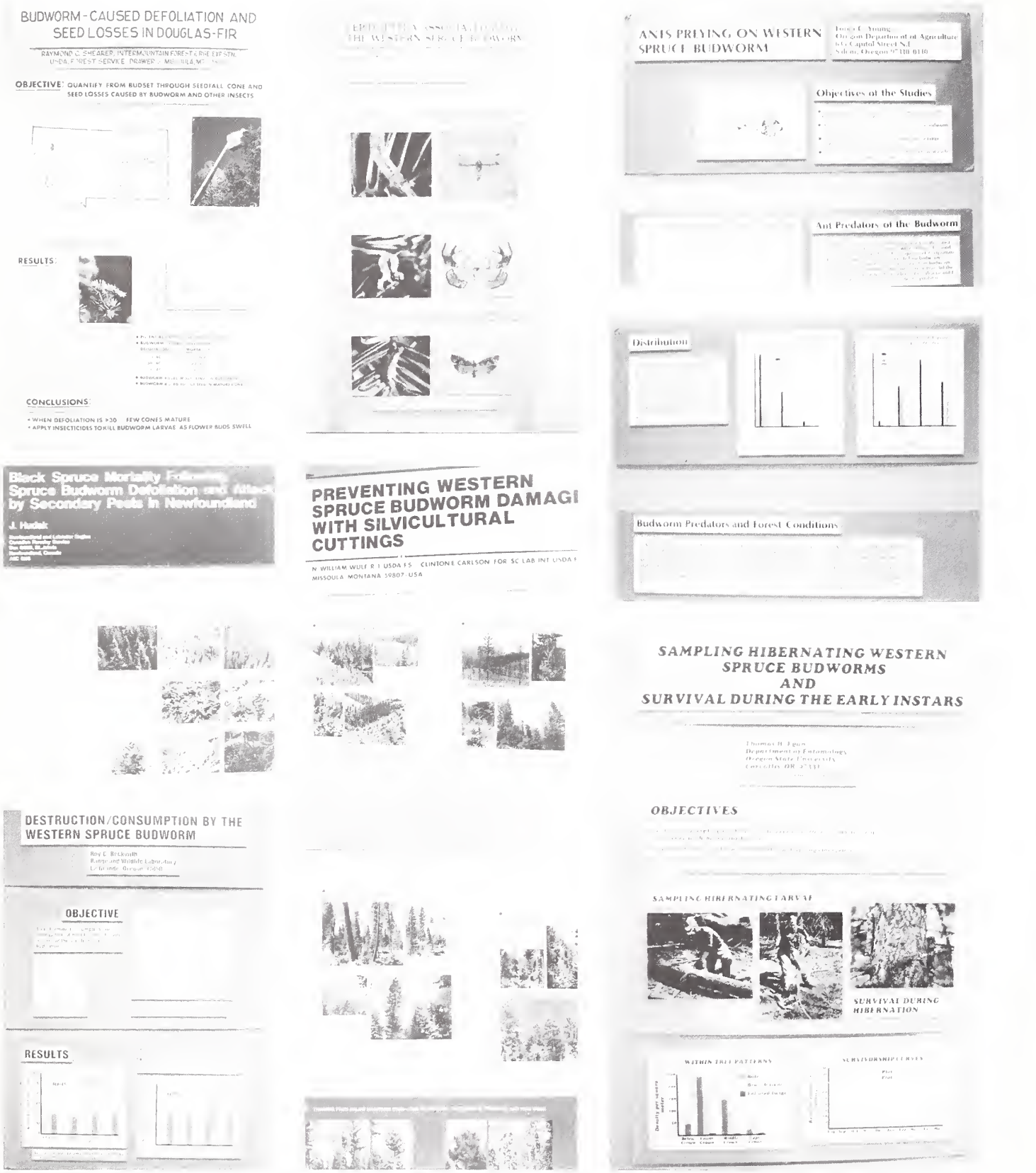
Early Monday morning, September 17, Fred Knight welcomed attendees and Keith Shea and George Green gave an interview of the CANUSA Program from their historical perspectives (fig. 8). Keith was sitting in for Bob Buckman, who had to be in Europe for an IUFRO meeting. George was a last-minute sub, in for Carl Winget, Canadian Forestry Service Director General of Research and Technical Services. The rapidly changing political picture in Canada following Prime Minister Mulroney's election required Winget to stay in Ottawa for high-level talks within the Administration.

Mornings of the symposium were devoted to synoptic papers on four topics: (1) Biology, ecology, and population dynamics of the spruce budworms; (2) Economic and social impacts of spruce budworms in North American forests; (3) Tactics and strategies for prevention and suppression of damage by spruce budworms; and (4) Integrated forest and pest management: implications for forest management. In each talk a moderator introduced several speakers who gave a synthesis of CANUSA's contributions in each subject area. These speakers had been chosen by Program management to reflect a cross-section of American and Canadian scientific views.

During morning coffee breaks, guests and speakers mingled in the lobby (fig. 9) and checked out the poster displays.

Each afternoon, attendees were offered less formal presentations on topics related to the morning's talks. These "workshops" were handled with a moderator-and-panel approach, and questions from the audience were encouraged. A full copy of the program concludes this summary.

The social highlight of the week was the clambake. Attendees and their partners rode up to the Maine campus for a buffet feast of lobster or steak plus clams and all the trimmings.



Figures 1-7. A few of the posters provided by funded investigators from the Program. The University of Michigan-Michigan State group brought eight, all topped with bright orange strips behind each title. Unfortunately, the fabric-covered, stand-alone panels supporting each poster were the same color. The UM/MSU posters essentially faded into the woodwork!

Figure 8. At left, Keith R. Shea, USDA Forest Service Associate Deputy Chief for Research, applauds as George Green, of the Canadian Forestry Service's Sault Ste. Marie lab, returns to his seat. At right is Fred Knight, Dwight B. DeMerritt Professor of Forestry at the University of Maine, Orono. Fred served as general director of the symposium and liaison between CANUSA and the university in ironing out convention details.

Proceedings of the meeting are currently in preparation in Ottawa. The Canadian Forestry Service volunteered to handle editing, typesetting, and design for the book because the CANUSA-U.S. Program shut down just a week after the meeting. The proceedings, which will come out in 1985, will include the synthesis papers from the morning sessions, brief summaries of the afternoon workshops, and abstracts of the posters. The book will be published in English with French abstracts.

No one in the audience believed the CANUSA Program had solved the spruce budworm "problem", but general consensus was that the joint effort between the United States and Canada established a working relationship between scientists from both countries, a relationship that should advance budworm research further and faster than either nation could have done on its own.

Janet Searcy — Information Coordinator, CANUSA, Washington, DC

Figure 9. About a third of the crowd, shot from the Bangor Civic Center balcony during a coffee break. Attendees enjoyed such lively talks during the breaks that moderators had trouble getting them back into the hall.

Program for the Bangor Symposium

Spruce Budworms — Biology, Ecology, and Population Dynamics

Moderator: **W. Lloyd Sippell**, retired Program Manager, Canadian Forestry Service, Great Lakes Forest Research Centre, Sault Ste. Marie, Ontario

Speakers: **G. T. Harvey** on taxonomic status of *Choristoneura* spp.
J. Robert Blais on the ecology of the eastern spruce budworm
Roy F. Shepherd on the western spruce budworm: strategy for survival
W. Jan A. Volney on commonalities and differences between eastern and western spruce budworms

Affiliated Workshop: Population Dynamics

Moderator: Max W. McFadden, former Program Manager for CANUSA-West and now working for the Agency for International Development, U.S. State Department

Speakers: **Alan J. Thomson** on the role of environmental factors in regulating budworm populations
Robert W. Campbell on the role of predators
Mark Houseweart on the role of parasites
D. Perry on the role of diseases
Roy C. Beckwith on budworm behavior
William J. Mattson on host–plant interactions
Chris J. Sanders on what we can learn from historical records of budworm attacks

Economic and Social Impacts of Spruce Budworms in North American Forests

Moderator: **R. Harold Tremblay**, adviser to the Deputy Minister (Lands and Forests), Department of Energy and Resources, Quebec, PQ

Speakers: **David A. MacLean** on the impact of the spruce budworms on forest productivity
Tom D. Bible on the economic consequences of budworm outbreaks
Brian J. Stocks on budworm damage and fire hazard
Nicholas L. Crookston and **Robert S. Seymour** on forecasting growth and yield of budworm-infested forests

Affiliated Workshop: Population and Impact Assessment

Moderator: **William E. Waters**, University of California, Berkeley

Speakers: **Arthur G. Raske** on determining insect numbers
Dale S. Solomon on quantifying budworm impacts on growth and yield
William B. White on quantifying impacts on other forest resources (wildlife, range, water, etc.)

Tactics and Strategies for Prevention and Suppression of Damage by Spruce Budworms

Moderator: **I. William Varty**, Canadian Forestry Service, Maritimes Forest Research Centre, Fredericton, NB; and **Wyman C. Schmidt**, USDA Forest Service, Intermountain Forest and Range Experiment Station, Bozeman, MT

Speakers: **Barton M. Blum** on potential silviculture, harvesting, and salvaging practices in eastern North America
Clinton E. Carlson, Wyman Schmidt, and **David G. Fellin** on forest protection in western North America: the silvicultural approach
Jack A. Armstrong on tactics and strategies for suppression and prevention of damage
J. C. Cunningham on the status of biorational agents for controlling the budworms

Concurrent Affiliated Workshops:

1. Forest Stands and Budworms

Moderator: **Wyman C. Schmidt**

Speakers: **John A. Witter** on the characteristics of susceptible/vulnerable stands
David G. Fellin on hazard rating
Karel G. Stoszek on silvicultural strategies to reduce susceptibility/vulnerability

2. Techniques of Foilage Protection and Population Manipulation

Moderator: **I. William Varty**

Speakers: **Jacqueline L. Robertson** on chemicals
John B. Dimond on biorationals (microbials, viruses, insect growth regulators, pheromones)
Charles J. Wiesner on applications technology

Integrated Forest and Pest Management: Implications for Forest Management

Moderator: **Ronald W. Stark**, University of Idaho, Moscow

Speakers: **Gary A. Simmons** on integrated pest management of spruce budworm in the eastern United States
Wilf Cuff on integration of forest and pest management in eastern Canada
Albert R. Stage on integration of forest pest management: Implications for western forest management

How Successful Have We Been in Achieving the Goals of the CANUSA Program?

Chairman: **C. Robert Blomquist**, USDA Forest Service, Eastern Region, Timber Management, Milwaukee, WI

Panel Participants: **Jean-Claude Mercier, Wayne Maahs, William M. Ciesla, Richard B. Anderson, Jerry R. Williams, J. Rodney Carrow**

JPU and JPPC Wrap It Up in Bangor

The two committees that guided the CANUSA Program met for the last time in Bangor during the September research symposium. On September 17, cochairmen Gerald Anderson and Murray Nielson joined Jim Stewart, Jack Armstrong (standing in for Les Carlson), Gerard Paquet, and CANUSANs Mel McKnight, Chuck Buckner, Dan Schmitt, Jim Colbert, Janet Searcy, and Canadian Forestry Service (CFS) editor Jim Mullins to tie up three important details.

1. The Joint Planning Unit (JPU) felt there was a need for formal documentation to provide for the two lead agencies (USDA Forest Service (FS) and CFS) to continue coordination, cooperation, and exchange of information on spruce-budworms-related research. Paticularly important, they felt, was the inclusion of "development and application" activities in any future agreement between the two countries. The JPU decided that a modified version of the mountain pine beetle supplement to the Canada–U.S. Memorandum of Understanding on cooperative forestry-related programs would provide appropriate documentation. Program Leaders McKnight and Buckner supplied a draft supplement originally presented at the 1983 JPU Meeting, and this was further revised on the spot. In its first action item, the JPU recommended to the Joint Policy and Program Council (JPPC) that the supplement be entered into under the existing Memorandum of Understanding for forestry-related programs.

2. The future of the CANUSA *Newsletter* came up next. At last year's JPU/JPPC meetings, the subject of continuing the *Newsletter* was discussed, but no conclusions were drawn concerning its future sponsor or format. Since that meeting, both the CFS and the FS's State and Private Forestry office in Broomall, Pennsylvania, have offered to publish the *Newsletter*. At the 1984 meeting, the JPU decided that the Canadian Forestry Service's offer to continue producing the *Newsletter* in both French and English should be accepted.

The Canadians will continue to typeset, lay out, print, and distribute both versions as they have been doing during CANUSA, but they will depend on input of feature articles and calendar items from contributors in both countries. While formerly the U.S. items were assembled in Washington, in the future the Northeastern Area of State and Private Forestry, in Broomall, will assume the lead in collecting and rewriting U.S. contributions.

The JPU considered broadening the subject matter to cover other pest and forestry-related issues, such as other insects, diseases and acid rain, but decided to keep the focus on the spruce budworms alone. A possible title for the new publication will be *Spruce Budworms Information Digest*, a change suggested to identify content but eliminate the connotations of time-sensitive material that go with the word "newsletter." It was left to the publishers to decide on the masthead, but it was agreed that the words beneath the CANUSA maple-leaf-star logo would be deleted. The publishers will consider further whether or not the remainder of the logo should be retained.

The JPU also addressed the subject of frequency of publication. After considerable discussion, the committee decided to attempt publishing the new digest on the same every-second-month schedule the CANUSA *Newsletter* has used. Naturally, the success of this plan depends on the Broomall and Ottawa camps receiving regular contributions from budworms researchers, so we encourage everyone reading this article to consider writing for the new information digest on a regular basis. Short features, calendar items, and publication notices are most especially desired. On the U.S. side, send your contributions to the Editor, *Spruce budworms Information Digest*, USDA Forest Service, Northeastern Area, State and Private Forestry, 370 Reed Road, Broomall, PA 19008. On the Canadian side, Chuck Buckner will be handling contributions at his usual address, Canadian Forestry Service, 19th Floor, Place Vincent Massey, Ottawa, Ontario K1A 1G5.

In the action item related to this topic, the JPU recommended to the JPPC that its members encourage their respective agencies to provide feature articles for the new publication. The bimonthly publication schedule and the role of the CFS in underwriting the cost of typesetting, layout, printing, mailing, and maintenance of the address list were spelled out. In addition, Ottawa will supply French translation services so the digest can continue to serve its bilingual audience.

By the way, readers receiving the CANUSA *Newsletter* will automatically get the *Spruce Budworms Information Digest*. Submit new names for the mailing list directly to Chuck Buckner at the address given above.

3. The JPU wished to document its recognition of the importance of the spruce budworms literature data base that has been maintained on the computers at the Oak Ridge National Laboratory in Tennessee. This data base has already generated four bibliographies, which will be combined in 1985 to produce a single volume of citations and indexes in the USDA Bibliographies and Literature of Agriculture series.

Presently Dan Jennings and Mel McKnight are entering new materials and rechecking old citations against original documents. The Forest Service's Deputy Chief of Research agreed to support this work until publication of the composite bibliography in 1985.

The future of the bibliography project beyond that date has been a concern of the JPU for more than a year now. Chuck Buckner reiterated CFS's willingness to take over the bibliography project for at least 2 years beyond the end of U.S. involvement. The Canadian commitment will involve financial support for transfering the computer files and operating systems from Oak Ridge and training personnel how to analyze a document and enter its description into the data base.

The FS agreed to facilitate transfer of the files and operating systems and to help with training as required.

In an action item, the JPU formally thanked the Canadian Forestry Service for its interest in the bibliography project and its willingness to take over data entry and storage for at least a 2-year period. The JPU recommended that the JPPC accept this offer and effect the transfer of the data base into Canada when the USDA summary publication has been printed, late in calendar year 1985.

The latter half of the JPU meeting was devoted to information reports. Chuck Buckner summarized the highlights of the CFS budworms research program in a final report to the committee. He emphasized the development of alternative management strategies besides chemical intervention for dealing with the budworm. The Canadians consider mating-disruption techniques to have high potential, but progress has slowed because of lack of funds for research to identify the minor components of the pheromone blend that stimulate moth response.

Jim Colbert and Dan Schmitt summarized the status of their respective programs in written reports. Both called attention to areas of concern that require post-CANUSA funding assistance. In the West these involve completing and documenting the PROGNOSIS–Budworm Model and preparing for commercial production of the automated egg-mass counter. In the East, three technology transfer projects (Lake States, Vermont, Maine) are well developed but need continued FS financial support. Working groups developed under CANUSA-East have potential for continued good across-the-border relations under the proposed supplement to the Memorandum of Understanding. Future refinement of the egg-mass counter and its demonstration are important to eastern forest managers also.

The JPU recommended that the JPPC consider the areas of concern expressed in the Program Leaders' and Managers' reports and encourage the FS and CFS to support by base funds the specified subject areas highlighted.

In another information report, Janet Searcy summarized the status of the American publishing effort. She announced the publication of seven USDA series publications and mentioned that six more would be in print by late fall. Twenty of the original 40 series handbooks will not be printed until U.S. fiscal year 1985. The necessary monies to finance the 1985 publications effort (about $60,000) will be provided from the USDA Forest Service Washington Office budget.

Janet also described the successful completion of last year's video tape project with cooperators from the University of Michigan and Michigan State. Both the eastern and western components' tapes are finished and reproduced for use in the field. Copies were being shown continuously in the Bangor Civic Center lobby. The CFS has produced French translations and redubbing of the audio portions of the tapes so the same information will be available for our francophone audience.

Mel McKnight reviewed the status of the R&D Management Inventory. The last issue (no. 9) was distributed in June 1983. At last year's JPU/JPPC meetings, Chuck and Mel announced their intention to update the computer file and make available a tenth issue during 1984. This work was put aside, however, in favor of higher priority work in preparing the USDA series publications during 1984.

In its final action item, the JPU recommended to the JPPC that an attempt be made to update the R&D Management Inventory to reflect the status of all CANUSA-sponsored research as of September 30, 1984, and that a final version of the Inventory be prepared and distributed in 1985.

The JPU meeting closed with a formal commendation of the Canadian and U.S. Program Leaders and Program Managers for their efforts throughout the life of CANUSA.

The JPPC Responds

On September 19, with one day off for report preparation, the JPU presented its recommendations to the Joint Policy and Program Council (JPPC). Keith Shea and George Green stood in for JPPC cochairmen Robert Buckman and Carl Winget. In point of fact, only Fred Knight of the "real" JPPC was present. John Ohman was represented by Jim Stewart, Ross Macdonald by Al Thomson, Rudy Hanusiak by Rod Carrow, and Jack Sullivan by John Meadows. The JPU was represented by Gerald Anderson, Murray Nielson, and Gerard Paquet, plus Jim Stewart, who found himself playing two parts simultaneously. Program Leaders and staff (McKnight, Buckner, Searcy, Schmitt, and Colbert) rounded out the list of participants. Bob Romancier, from the Northeastern Forest Experiment Station; Glenn Cooper, from Pacific Northwest Station; and Bob Blomquist, from the Eastern Region of the Forest Service attended as guests.

The JPPC accepted the JPU's recommendation that a post-CANUSA supplement to the existing Memorandum of Understanding for cooperation in forestry-related programs be developed, based on the draft supplement for spruce budworms research, development, and application worked over by the JPU.

The JPPC accepted the CFS's offer to produce future issues of the new publication succeeding the *Newsletter*, which was seen as conditional on both countries designating a person to coordinate contributions for a 5-year period following the final issue of the CANUSA *Newsletter*.

The JPPC also accepted the CFS's offer to assume responsibility for the spruce budworms bibliography project for at least 2 years after publication of the USDA-series composite bibliography in 1985.

Next, the JPPC heard information reports on program highlights, research, technology transfer, and the management inventory. JPPC members agreed to forward the reports from both Program Leaders and the U.S. Program Managers to their respective agencies for consideration in research planning and budgeting. Additionally, the JPPC urged the CFS to seek opportunities to adjust funding priorities so that research on the spruce budworm pheromone blend can proceed toward development of the mating-disruption technique.

The JPPC urged that the FS take whatever steps are necessary to facilitate refinement and commercial production of the automated egg-mass counter.

On the matter of publishing a final issue of the R&D Management Inventory, the JPPC endorsed the JPU's recommendation with the understanding that the inventory is of lower priority than the bibliography project and other planned USDA-series publications and the sequel to the *Newsletter*.

The JPPC meeting concluded with an echo of the JPU's commendation citing the efforts of Program Leaders and Managers in achieving the goals of CANUSA.

Maine-Maritimes Demonstration Tour

In the week preceding the Bangor research symposium, CANUSA-U.S. East and Ed Kettela and Company on the Canadian side hosted a demonstration tour that brought 20-odd "users" closer to the Maine–Maritimes budworm problem.

The group assembled at midday on **Monday, September 10**, for a short bus trip north of Bangor to the Penobscot Experimental Forest. Bob Frank, from the Northeastern Forest Experiment Station in Orono, guided the group through much of the 1 619 ha (4,000 acres) of spruce–fir that make up the forest. This parcel is jointly owned by 11 private timber and wood-using corporations and leased for 99 years to the Forest Service for research purposes. Stumpage cut from the forest pays taxes on the parcel; the owners receive no revenue from the forest.

Cover types on the Penobscot reflect its relatively thin layer of glacial soil, cool temperatures (4.5 °C, 44 °F average annual reading), and imperfect drainage. Balsam fir and red spruce predominate, with the oldest trees in today's stands at 75 to 100 years of age.

Most of the research in progress on the forest involves silvicultural manipulation of species composition and stand density to discourage the success of spruce budworm. Figure 10 shows how the forest looked when research began. Trees were very closely spaced, and some large specimens remained from prior logging. Windthrow left lots of debris on the floor, and evidence of budworm damage was clear.

Researchers are also looking into the effect of fertilization on tree growth in central Maine. The combination of early release through herbicides plus nitrogen (fig. 11) has led to significant increases in the growth rate of conifers.

Figure 10. From the edge of one of the Penobscot Experimental Forest's roads, Bob Frank shows us what the stands looked like before shelterwood cutting modified their structure. Bill Wulf, CANUSA regional representative from Missoula, Montana, is walking into the woods for a closer look.

Figure 11. Fertilizing with lime and urea in the spring of 1977 and 1978 promoted significantly faster growth in conifers, especially when early release with herbicides has been used to favor softwood species.

After strip- or clearcuts in Maine, balsam fir regenerates more successfully than other species. Because it is so susceptible to budworm-caused mortality, balsam is seen as less desirable than spruce. Figure 12 shows how successful the use of a three-stage partial cutting scheme has been in altering species composition to favor spruce regeneration. By 1981, only 7/10 of one fir tree was regenerating for every new spruce on the C23 plot, down from 15 firs to every spruce in 1964. Overall spruce stocking came up from 10 percent to 74 percent of the stand.

On **Tuesday** morning, September 11, the tour stopped by the Costigan stud mill run by the lumber and plywood division of the St. Regis Paper Company. The guide, Phil Malerba, explained that the merger of St. Regis into Champion International, which had been announced just the week before, created the largest timber corporation in the world.

The Costigan operation is a medium-sized mill using 331 500 m^3 (130,000 cords) of spruce, fir, and red pine per year. St. Regis put in a second headrig in 1984 and currently runs two shifts a day on a 5-day work week. The 10-year-old plant employs 125 people to produce 2.4-m (8-ft) or 1.2-m (4-ft), kiln-dried studs for construction. Surprisingly, 80 percent of this lumber is shipped to the Deep South.

From the plant, the bus proceeded to five stands showing various levels of budworm damage. St. Regis participates in Maine's budworm spray program and in 1983 paid the State $16(U.S.)/ha ($6.50/acre) to have *Bacillus thuringiensis* (B.t.) (Dipel®) applied at 30 BIU/ha (12 BIU/acre) to control high to extreme budworm populations in plots that had been precommercially thinned.

St. Regis foresters noted mortality after only 3 years of budworm defoliation and concluded that an aggressive spray program on fairly young trees was called for. In their Downeast region of heavy till and clay soils with poor drainage, 85-percent mortality of red spruce was found. Watershed conditions demanded the use of B.t. over chemical insecticides, and the company expressed satisfaction with it.

St. Regis has found that thinning trees to 1 500/ha (600/acre) in partial harvest operations leaves a stand highly susceptible to budworm attack.

Figure 12. Bob Frank points with pride to results of partial cutting in altering stand species composition to favor spruce regeneration.

In one stand heavily hit by budworm, St. Regis removed all spruce and fir to prepare the area for regeneration to white pine. Well-drained soils are felt to be very conducive to growth of this species, which is not a favored food of the budworm.

Finally, the group was taken to a black spruce plantation, one of St. Regis's relatively few efforts to change species composition on its lands. In the last decade, the company has planted over 5 000 ha (12,500 acres) of its timberlands in Maine. Following a 1983 mechanical harvest on the 30-ha (75-acre) plot we saw, the company outplanted 25,500 containerized black spruce seedlings. Previous experience with bare-root stock had been disappointing, but St. Regis is expecting 85-percent seedling survival after two growing seasons in the area we visited.

Tuesday afternoon the group travelled north in a shiny new bus through Maine and crossed the border into Canada at St. Stephen, New Brunswick. Ed Kettela, from the Canadian Forestry Service's Maritimes Forest Research Centre, took over as tour director.

The 4-hour ride was broken by a short stopover at the Brockway airstrip of Forest Protection, Ltd. (FPL). Its manager, H. J. (Bud) Irving, reviewed the New Brunswick spray picture with a giant wall map demonstrating chemical and B.t. spray areas in two colors. Sprayed acreage was down somewhat in 1984, but Bud stated that FPL will provide spray services to "anyone who asks for it." TBM Avengers handle large blocks, and the company uses helicopters for smaller ones.

Intermittent rain and dark skies made for an early evening as the bus pulled into suburban Fredericton for the night. But before we lost the light, Ed pointed out numerous budworm-damaged stands by the highway. South-central New Brunswick has many farms, especially in the St. John River valley, so there were no stretches of uninterrupted spruce–fir like those in Maine. But the budworm did not disdain the scattered feast in the Maritimes.

Bright and early **Wednesday** morning, September 12, the tour headed for the New Brunswick Forest Nursery, run by the Province's Department of Natural Resources. Nils Freiburg led the tour of the facility,

Figure 13. Thousands of white spruce seedlings in the New Brunswick Forest Nursery grow in their Japanese paper pots. Note the water and fertilizer apparatus that swings up and down the aisle in its own wheel tracks. Fans and louvered vents in the rear wall control temperatures.

Figure 14. This fir seedling had no trouble sending its roots through the walls of its paper container.

showing off his clean, modern seed-collection and -sorting areas, the greenhouses, and outdoor beds where bare-rock stock is grown.

The nursery manages a Province-wide seed collection effort using seasonal help, often the same people year after year. Pickers submit bushels of cones in carefully marked burlap bags. A bushel of pine cones yields about 454 g (a pound) of seeds, while the same amount of black spruce cones produces just 114 g (4 oz) of seeds.

Many of these seeds find their way into cleverly designed Japanese paper pots, where they are grown to planting size. The pot system is a flat, treated-paper affair that expands into a multicell, accordion-pleated standup container that holds dozens of seedlings. The paper device is then stapled into sturdy, reusable trays. A soil and peat mixture is dropped in along with a seedling, and the trays go directly into the greenhouse (fig. 13).

Because almost all of this year's seedlings had been shipped, the group could only see some "losers" — seedlings too spindly or short for outplanting. But these little fellows looked pretty good for a bunch of rejects! Figure 14 shows a typical specimen, its paper cell removed and soil shaken off to display a husky root structure.

Bare-root seedlings supplied by the nursery sell for about $75 (Canadian) per 1,000. This price includes lift-

ing from the field and packing but not trucking to the buyer. Containerized seedlings in the paper pots go for between $60 and $95 per thousand. Utility bills to run the greenhouse in cold weather drive up the price to $95 for the winter-grown crop.

Another important function of the nursery is maintenance of seeds in carefully monitored environments for the purpose of germ plasm research and provenance studies. Seeds are stored up to 6 years at temperatures just below freezing. Moisture content of the seeds is kept at 5 to 8 percent.

From the nursery the tour continued to the largest privately held forest under cultivation in New Brunswick. J. D. Irving, Ltd., an oil and forest products conglomerate, is run by a bunch of tree lovers! The company's enormous freehold occupies thousands of acres of beautiful rolling country interlaced with crystal streams. Beside the headwaters of the Restigouche, the group munched company sandwiches and chatted with Tom Marceau, the J. D. Irving guide.

He showed us numerous plots, some with evidence of spruce budworm damage but most in very good shape. At the Black Brook forest area, there were planted stands of Norway, black, and white spruce. Figure 15 shows an Irving hillside with mixed conifer species. In the foreground, young white spruce about 3 m (10 ft) tall showed no sign of budworm damage. Taller black spruce in the middle distance carried very heavy cone crops. (This has been a banner year for reproduction all over the Maine–Maritimes area.)

Three hours later the tour arrived at Rivière du Loup, on the south bank of the St. Lawrence River in Quebec. After dinner as guests of the Quebec Ministry of Energy and Resources, the tour members turned in early to prepare for a day in the field with Louis Dorais.

Thursday began at the Rivière du Loup airstrip that serves as home base for Quebec's budworm spray program, which operates under Louis's direction. Since June 1981 (see *Newsletter* No. 18, September 1981), B.t. tanks have sprouted like mushrooms all over the complex (fig. 16), where formerly Matacil® and fenitrothion ruled alone.

Louis began by assembling our party in a spic-and-span tool shed for a review of the 1984 spraying plan for the whole Province (fig. 17). Quebec never treats more than 10 percent of the budworm-infested area in any one year. In 1984, 800 000 ha (nearly 2 million

Figure 15. J. D. Irving, Ltd., lands at Black Brook stretch as far as the eye can see—and farther. Young white spruce share the foreground with nodding wildflowers. Taller black spruce carry heavy loads of cones, part of the 1984 bumper crop.

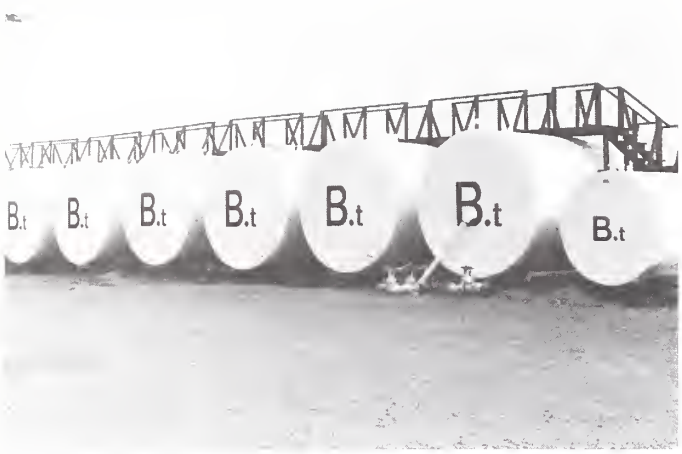


Figure 16. Some of the 37 854-L tanks for mixing and holding B.t. at Riviere du Loup.

acres) were sprayed; 40 percent received B.t. and 60 percent, chemicals (fenitrothion or Matacil®).

Louis's crews operate out of three airports using nine 4-engine planes (three DC-6's, two Constellations, four DC-4's). For small plots, AgCats and Turbo Thrushes are used.

Louis provided some interesting cost figures for the 1984 spray effort. Total costs included the insecticide plus mixture ingredients, application expense, and postspray environmental survey. Two applications of chemicals cost $10(Canadian)/ha ($4/acre), while a single application of B.t. at bud flare cost $23/ha ($9.31/acre).

Each of the split applications of chemicals delivered 1.4 L of insecticide per ha (20 fl oz/acre). In previous years, the B.t. was applied at 4.6 L/ha (1/2 gal/acre) in a viscous suspension. But this year Quebec tried using B.t. "neat," right out of the can with no stickers or additives. The single-application dosage was 2.3 L/ha (1/4 gal/acre), which provided 30 BIU/ha (12 BIU/acre) of active ingredient.

Quebec is thus in an unusually good position to comment on the efficacy of B.t. *vs* that of chemicals. Louis told us, in response to a question from the audience, that "B.t. is as good as chemicals if it is applied right." One potential catch here is the smaller spray window for the single application of B.t. Louis claims that the B.t. "season" is only 20 days long, compared to 30 days for chemicals.

The Rivière du Loup spray effort used Norm Dubois's new B.t. isolate—NRD 12—experimentally in the field in 1984, but results were not available at the time we visited.

Louis next led a walk through the equipment yard to look at mixing drums (fig. 18) and pumping systems (fig. 19). On the far side of the airstrip are a row of brown 37 854-L (10,000-gal) tanks for storing mixed supplies of chemical insecticides (fig. 20). The B.t. tanks are completely separate. Figure 21 illustrates a full summer's supply of empty drums, rinsed out and waiting to be sent back to the insecticide manufacturers for reuse.

The airstrip was quiet, but activity hummed in the laboratory trailer supervised by Jean Cabana (fig. 22). His crew was busy culturing spores from water and soil samples collected in B.t. spray areas (fig. 23).

Jean also did some investigations on how various brands of B.t. reacted with metal fittings of the materials found in spray systems (fig. 24). Dipel® proved more corrosive than Thuricide®.

Every single spray plot in Quebec is monitored by Jean's staff with Kromekote® cards or plates to catch insecticide deposit. His crew works all winter on processing those samples as well as water and soil samples taken in the same spots at various time intervals after spraying. Protection of water quality and reduction of insecticide drift are high priorities in the Province.

On Thursday afternoon, Louis took the group into the woods to examine four blocks with different spray histories. The first block had been sprayed yearly since 1975 and received B.t. for the last 3 years. The second block received chemical insecticides annually except for 1980 during the same 10-year period. Block 3 was sprayed from 1975 through 1979 but has received nothing since then. And the final area had parts with no spray history and parts that were sprayed once, twice, or three times since 1975. Blocks 1 and 2 were virtually indistinguishable: yearly spraying, regardless of chemistry, provided good to excellent foliage protection despite high budworm pressure. Block 3, not sprayed since '79, showed significant budworm wear and tear (fig. 25). Block 4 was a wasteland (fig. 26).

A number of plots were visited where some trees appeared perfectly healthy and others, side by side, were dead. Figure 27 illustrates such a curiosity. Research is needed on those "survivor" trees to find out how they differ genetically and chemically from their dead neighbors.

Figure 17. In front of a row of freshly painted pumps, Louis Dorais explains Quebec's spruce budworm spray operations using a map with spray plots shown in color. That arching waterway running from the lower left to the top right is the St. Lawrence River. The right-hand promontory is the Gaspe Peninsula, and the left-hand section is called the "lower St. Lawrence."

Figure 18. Louis shows Ed Kettela part of the enclosed mixing system used for handling all the insecticide solutions prepared at Riviere du Loup.

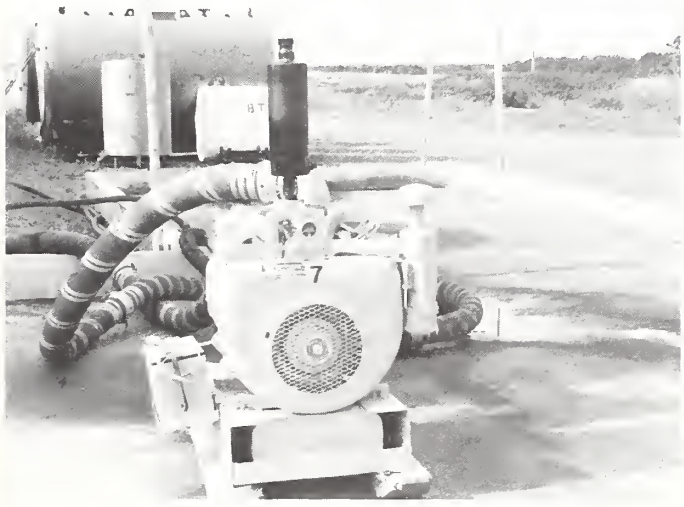


Figure 19. Part of the hose and pumping system that brings insecticide from storage drums (rear) to the planes. At no time do human beings touch any of the pesticide product.

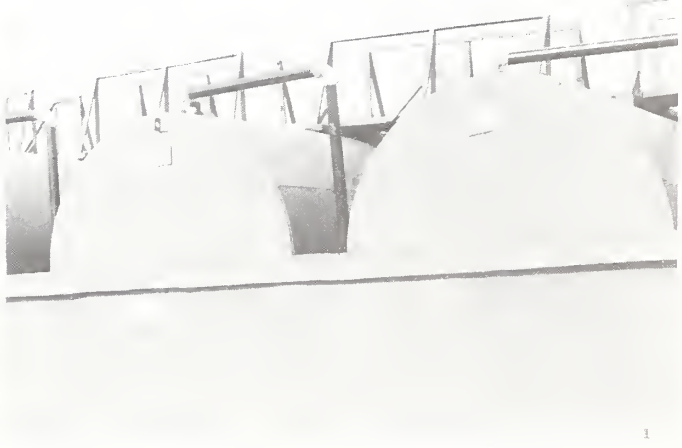


Figure 20. Two of the 37 784-L drums that hold mixed Matacil (MMA) and mixed fenitrothion (MFE).

Figure 21. The 1984 crop of empty insecticide drums waiting to be returned to the manufacturers.

Figure 22. Mel Weiss, from the Forest Pest Management staff at Durham, New Hampshire, looks on as Jean Cabana, in the lab coat, explains how his facility cultures B.t. spores from aerial spray deposits. At right, a technician inoculates agar plates with spores taken from water sources in the spray path and passes the plates over a Bunsen burner.

Figure 23. A plastic sack of soil from under a spray plane's path and agar plates with spore cultures of various ages.

Figure 24. Jean Cabana points out how some brands of B.t. are more corrosive to brass fittings (valves, etc.) than others.

Figure 25. Rejean Bergevin (left) and Harold Tremblay, both from Quebec Province, discuss the status of trees on the edge of a clearcut. This plot, not sprayed since 1979, has some healthy trees, on the left, but many dead and defoliated ones, toward the right.

Figure 26. A few of these trees are still alive, but all show significant defoliation.

Figure 27. Klaus Maksymov, of the Swiss Federal Institute of Forestry, takes a closeup of budworm damage. Klaus was our tour member from the farthest port.

Figure 28. Michel Auger discusses Quebec's spray program and its followup lab work. At the left, his four-chambered white plastic pot with viewing window for holding 45-cm branch tips collected in the field.

Figure 29. Canada's new Multi-Pher pheromone trap—white plastic with a green lid.

Figure 30. With a telescoping pole and custom-fitted plastic basket, field crews have no trouble installing Multi-Pher traps well up in the tree crown. Retrieval is just as simple.

Louis thoughtfully arranged the itinerary to bring the bus closer to Quebec City with every stop. On **Friday** morning, the 14th, the tour visited the Quebec Ministry of Energy and Resources' lab on the edge of the Laval campus. First Louis showed off the lab, the egg-mass counters (all male!), and arranged a demonstration of the equipment for performing caustic soda washes to dislodge budworm material from branches.

Next, Louis turned over the microphone to Michel Auger (fig. 28) for an explanation of the lab work that follows every spray season. He described the Province's efficacy tests and parasitism work.

Following Michel, Luc Jobin showed off his modified version (fig. 29) of the covered funnel trap. The new trap carries the Environment Canada patent but can be manufactured by any private-sector firm that applies for the privilege. It is called the Multi-Pher because the trap is suitable for implanting with the synthetic phero-

mones of many different insect species. The trap has already been tested on gypsy moth and spruce budworm and has proven more durable and significantly superior in attractiveness to the insects.

Basically a two-piece affair, the Multi-Pher trap has a green plastic lid and a white body—the color white having been found more attractive to insects than green or yellow, the colors of competitive trap designs. The cagelike affair hanging down from the lid is just what it looks like: a badminton shuttlecock. The cage serves as a point from which to suspend the pheromone lure.

The Multi-Pher trap can be hung high in the tree crown with ease, as Luc's technician demonstrated later that afternoon (fig. 30). A telescoping pole with a plastic basket made to fit the trap is used to get the Multi-Pher up to correct altitude, or to retrieve the trap in a vertical position so dead moths don't fall out during the descent.

On Friday afternoon, Louis, Michel, and Luc accompanied the tour bus on its visit to the Montmorency Forest an hour north of Quebec City. The forest is operated by Laval University as a research station and summer training camp for its undergraduate forestry students.

The students' dormitory and central compound overlook steep, wooded hills with a cover almost entirely of balsam fir and spruce. The forest was acquired by the university in a land swap not too long ago, after its previous owner had thoroughly logged the area's accessible stands. Second growth had reached maturity in many spots, and, as resident engineer Paul Bouliane told us, the forest has plenty of budworm problems.

Paul estimates that at least 324 ha (800 acres) of merchantable stands sustained severe budworm damage, in a 1 822-ha (4,500-acre) area running up the center of the Montmorency. Spraying done elsewhere could not be used to protect this area because of the students' dwelling, watershed runoff, and geographical factors in the Montmorency River valley.

Paul expects to salvage up to 25 000 m^3 (10,000 cords) of budworm-killed timber by the end of the present outbreak. The cutting spots are small (0.4 to 12 ha, 1 to 30 acres) and widely dispersed. Fortunately, the forest's good road system enables the harvesting crews to get close to most of the stands.

Timing of salvage is critical. Paul believes that losses in merchantable volume can be reduced if stands can be harvested at the right time. In stands with greater than 50-percent mortality caused by budworm, Paul's crews have measured volume losses up to 30 percent. The provincial government has graciously conceded stumpage dues to help the Montmorency Forest recover their expenses in salvaging after the budworm.

On Friday night, the last in Quebec, Ed Kettela, the Maritimes host, left for home. Bright and early **Saturday** morning, the tour headed back to the United States and a rendezvous with our last industrial host, Scott Paper Co.

Scott hosts met the group at Jackman, Maine, presented coffee and a slide show, and led 4 hours of serious tromping through the woods. The order of stops was almost straight east of Moosehead Lake and then south to the endpoint for the tour, the Squaw Mountain Resort overlooking the southwest quarter of the lake.

Government forecasts and studies by Scott's own people predict a shortfall in softwood occurring between 2000 and 2020. If this happens, Maine's timber industry will be seriously threatened. Scott is taking steps now to improve the growth, quality, and yield of its Maine softwood resource.

Their program is intensive silviculture with a three-part attack:

1. Harvesting low-quality hardwood stands either by conventional harvesting or biomass operations, and converting these hardwood areas to softwood plantations.
2. Releasing naturally regenerated softwood reproduction from brush/hardwood competition by applying herbicide.
3. Precommercially thinning young, naturally regenerated stands to improve species composition, reduce the number of stems, and improve individual tree spacing.

By the end of the 1984 field season, Scott will have implemented these plans on about 6 475 ha (16,000 acres). The company intends to increase such activities through 1990.

At stop 1 there was a biomass cut and brand new plantation. The stand had been cut in 1970, with removal of all high-quality hardwood and spruce–fir pulpwood. Last fall (1983), a private contractor removed all biomass on the site for fuel chips. Scott determined that no other site preparation was needed, and in May of 1984, an Arkansas tree-planting firm put in 1,730 red pine seedlings per ha (700/acre).

This year's planting contract called for a revolutionary departure from business as usual. Scott agreed to pay the planters a bonus if their people's work checked out by quality-control personnel at better than 85 percent "successful" plantings, on a per-worker basis. At first the crews grumbled, but the new philosophy proved sound. The prospect of fatter paychecks stimulated the crews to astonishing levels of workmanship.

Unlike the seedling growers visited in New Brunswick, Scott's people feel that bare-root planting is more successful in Maine than use of containerized seedlings. In studies during previous years, Scott found that many paper-pot seedlings were unable to put roots out of their containers. Five-year-old seedlings remained tiny, though alive, and when pulled revealed hard masses of roots balled up inside the container.

The land on stop 1 was fairly rough but dotted with this year's plantings, growing nicely. Our hosts brought out a full flat of spruce seedlings and a flat with just two red pine seedlings (fig. 31) for us to examine. Bill Wulf checked out the root system of one red spruce (fig. 32) and found it well developed.

Figure 31. Scott's bare-root spruce (left) and red pine (right) seedlings in their plastic cells for carrying into the field. Planting crews attach the flats of cells all around their belts. The flats slant, but seedlings don't fall out. Onsite, each planter digs a hole with the dibble, detaches a seedling, drops it in the hole, and tamps it down. Care in this time-consuming operation was rewarded by a new cash bonus program for excellence.

Figure 32. Bill Wulf extracted a red spruce seedling from the flat in figure 31 to check its root structure. The planting dibble is shown full-length in the background.

Scott believes that the growing success of stands planted like this one depends, in the early years, on herbicide release. Land at stop 1 will be treated with herbicides in 1986.

At stop 2 the feature was a huge commercial clearcut from a 1982 harvest of sawlogs and pulpwood. The terrain was rough, and large boulders and small rocks dotted the landscape. Early this summer a contractor felled all leftover, nonmerchantable trees and piled them in long, widely spaced rows for burning this fall. The site was prepared for next spring's planting, using a clever new device—a spring-tooth brush rake—attached to a Timberjack grapple skidder. The company is delighted with the spring-tooth rake. When it makes contact with a boulder too big to move, one or more of the rake's "tines" simply compress and the rake passes over the obstruction. Afterwards, the rake's hydraulic system pops the compressed tine(s) back out to full length. Fixed-tooth rakes used in the past got tangled up instantly and shut down altogether in stands like the one at stop 2.

Figure 33. John McLean bends down a leader to check for white pine weevil.

At the third stop in Scott's silviculture demo tour, an area had been harvested in 1974 with natural regeneration coming in thereafter. In 1982 the company applied the herbicide Roundup® at 4.7 L in 42.4 L water/ha (2 qt in 4.5 gal/acre) to release softwoods overtopped by undesirable species of brush and hardwoods.

The results of precommercial thinning with the Hydro-Ax rotary cutter were evident at stop 4. After a commercial clearcut in the late 1960's, this stand regenerated to about 37 000 stems/ha (15,000/acre) of mixed conifers and hardwoods. In 1983, 3-m (10-ft) corridors were cut into the forest at 3-m intervals with the Hydro-Ax. Afterwards, brushsaw operators thinned the uncut strips to about 1 730 trees/ha (700/acre).

At the edge of one of these strips, John McLean, of the University of British Columbia, spotted evidence of white pine weevil (fig. 33). But on slicing open a branch (fig. 34), he found not the weevil but larvae of one of its common parasites. The galleries just to the right of his knifepoint actually contained the grubs.

Density control was the last silvicultural technique the Scott people displayed. The stand pictured in figure 35 had been thinned using a brush saw in 1982, reducing the stems per ha from a whopping 49 420 to 1 853 (20,000/acre down to 750). That 49 000 figure was the result of natural seeding after a commercial clearcut in 1966.

Figure 36 includes nearly everybody who had a part in this entertaining and educational trip. Special thanks go to Tom Skratt and Ed Kettela for taking charge of the many organizational details involved in carting so many people around so many places.

Janet Searcy — Information Coordinator
CANUSA, Washington, DC

CANUSA Visits the Land of Enchantment

Despite rumors to the contrary, the western spruce budworm kills trees. And there is plenty of evidence now obvious in the cool, narrow, steep canyons in the mountains ringing the desert and high mesas in northern New Mexico. This and more was viewed firsthand in mid-August by a contingent from the northern elements of the western CANUSA family.

Doug Parker, Director of Forest Pest Management in the Forest Service's Southwestern Region, arranged the visit, in large part to reap the benefit of the expertise of Wyman Schmidt and Dave Fellin of the Inter-

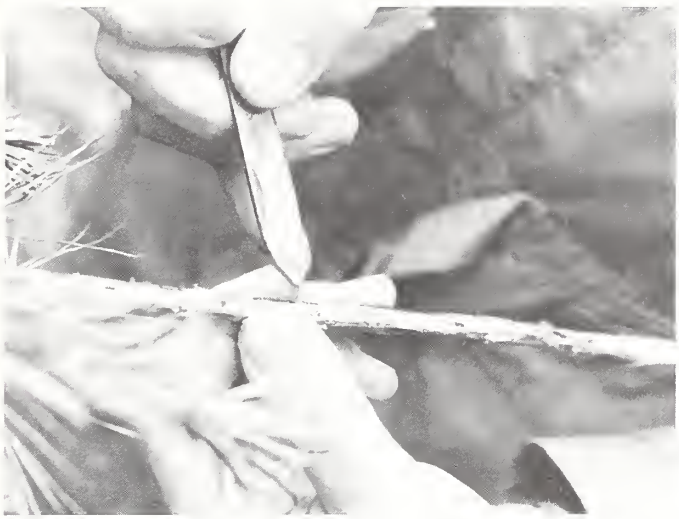


Figure 34. Cutting into a branch from the same tree revealed not the weevils but larvae of a weevil parasite.

Figure 35. While a Scott representative describes the history of this stand, Bill Wulf (left) and Eastern Region silviculturist Bob Blomquist (center foreground) check the species of ground cover. Peeking out from under Blomquist's nose is Dave Grimble, CANUSA-East's applications coordinator, now based in Orono.

Figure 36. Tour attendees, guest speakers, and various hangers-on took a moment out to pose for posterity on a bridge over the Montmorency River in the heart of the Montmorency Forest, in the Province of Quebec.

mountain Station's silviculture research project in Bozeman and Missoula, Montana. Jim Colbert, CANUSA-West Program Manager, and I were along to see the demonstration areas the Region had installed to gain experience in the use of silvicultural approaches to dealing with the budworm, and also to look in on the LaGrande (Oregon) unit's sampling study.

Early on a bright Monday morning, Doug picked up Wyman, Jim, and me in Albuquerque and set off for Taos; Dave had preceded us there on another mission. We stopped first at the headquarters of the Carson National Forest and visited briefly with Supervisor Jack Crellin. Stet Edmunds, Timber Staff Officer, explained the current situation and the issues concerning the budworm problem on the Forest. Almost in passing, we met Pam Walker, a landscape architect assessing the effects of the budworm in publicly viewed and sensitive areas, including application of Forest Pest Management-sponsored research on the visual impacts of the western spruce budworm (and mountain pine beetle).

Having picked up Dave in Taos we proceeded through Taos Canyon, getting our first look at the budworm situation, to the silvicultural demonstration area on the Taos Ranger District. This area of about 8 ha (20 acres) had been essentially clearcut of Douglas-fir and white fir, and subsequently underplanted with Douglas-fir to supplement natural regeneration of the original species. In a true application of integrated pest management, ponderosa pine had been planted around the edges because of dwarf mistletoe infections in the surrounding Douglas-fir stands. A stand of aspen, more vigorous than anticipated, had developed across the clearcut, to the delight of the wildlife management folks. There was ample evidence of considerable use of the available browse by elk and deer. Although the budworm had caused moderate to severe defoliation in the surrounding stand of Douglas-fir and white fir, there was little damage to the planted and natural regeneration of these species in the clearcut.

Later in the day, we stopped at Red River, a tiny community heavily dependent on summer tourists and winter skiers. In the ski area and along the heavily used highway through the steep, narrow canyon, severe defoliation and increasing tree mortality is evident. This is clearly another "damned if you do, damned if you don't" situation. Only a short time ago, a concerned public objected to a Forest Service proposal to treat the budworm outbreak before severe damage occurred; now the public is concerned that the Forest Service has not halted the budworm in its tracks, preferably far away and out of sight of the many users of the area.

On Tuesday, Doug was tied up on other business so the rest of us made our way to the Coyote District of the Santa Fe National Forest. At District headquarters in Coyote, we met Marty Morrison, District Ranger; Ray Stahl, Timber Staff Officer; and Wes Koch, Zone Silviculturist. Braced with an explanation of the management objective, and guided by Forestry Technician Joe Gonzalez, we eventually arrived at the proposed Cecillia timber sale in an area showing considerable budworm-caused damage to Douglas-fir and white fir. After a thorough scouting of the proposed sale, Wyman and Dave developed an opinion that the present prescription for the cut might indeed leave enough budworm-producing overstory to continue to infest the residual understory.

With Doug back at the wheel on Wednesday, we were off to visit the sampling study area on the Jemez District of the Santa Fe National Forest. At the study site we were met by Fred Schmidt from the LaGrande unit; Bill Route, a 3-year veteran of the study from the University of Idaho; and Dan Lenz, from the Jemez District. The purpose of the project is to validate budworm sampling systems developed by Bob Campbell and Torgy Torgersen in Oregon and Washington, and to calibrate the sampling schemes for southwestern budworm densities and tree species. Fred reported that preliminary analyses of the data indicate that the systems are producing population estimates well within the precision limits expected.

Fred also spoke in glowing terms of the excellent cooperation and support from Dan and others of the Jemez District staff. The good working relationships enjoyed here will benefit both the research team and the users of the research results.

Dan described some of the difficulties in implementing silvicultural approaches for dealing with the budworm. The Santa Fe and Carson National Forests have many acres of the mixed conifer, budworm-susceptible forest type. This type is just now coming under intensive management in this Region, where ponderosa pine seems to be the favored timber species. However, interest in the mixed conifers is quickening among the timber companies, even though cable yarding systems must be used in many situations because of the steep and fragile slopes.

Timber managers in this and other parts of the Region are faced with another interesting complication: protection of archeological sites which seem to be "everywhere." We were told that the Santa Fe National Forest has more such sites than any other National Forest in the country, and the Jemez District the most on the Forest. (The previous day we had met an all-female archeological team working on the Coyote District.) In spite of best efforts to identify and reserve such special places, accidents do happen and a logger occasionally may damage the site of an ancient dwelling, which may look to the untrained eye like nothing more than a pile of rocks.

On Friday, Wyman and Dave departed for home stations in Bozeman and Missoula, Doug got back to the business of dealing with the Red River situation, and Jim and I took advantage of the opportunity to visit with a few folks at the Regional Office of the Southwestern Region, Region 3, in Albuquerque. We met first with Dick Bassett, silviculturist, in the Timber Management Staff. Dick confirmed our impressions of the increasing emphasis in the Region on more intensive management of the mixed conifer type. Dick expressed a lot of interest in the applicability of the many resource-manager-oriented products produced by CANUSA-West over the past few years. Of special

interest is the high potential that the stand projection model, PROGNOSIS, with the linked budworm population model could, with some fine tuning, be used in the Southwest. This would give the Region 3 folks a badly needed and welcome tool for forest planning in the face of budworm problems which are certain to continue.

Finally, we visited with Jim Linnane in the Forest Pest Management staff. We learned a good deal more about how the pest managers see the budworm situation, and how they interact with the staffs responsible for management of timber, wildlife, recreation, and other resources of the Region to deal with a common problem.

All in all, it was an interesting and enlightening trip to a beautiful part of the world. The budworm is presenting forest managers with challenges and with opportunities to apply a body of knowledge and experience not only to protect but to also improve productivity of the forest resources under their stewardship.

Mel McKnight — CANUSA Program Leader
Washington, DC

Working Group on Integrated Pest Management Established in the Southwestern Region, USDA Forest Service

Western spruce budworm has become the major forest pest concern in the Southwest. The budworm is not new to the area: outbreaks were noted in mixed conifer forests in New Mexico in the 1920's. A peak of budworm defoliation occurred in 1954 on about 351 000 ha (867,000 acres) in Arizona and New Mexico. Defoliations occurred on an estimated 149 000 ha (368,000 acres) of mixed conifer forest in 1982, 153 000 ha (378,000 acres) in 1983, and somewhat over 162 000 ha (400,000 acres) in 1984.

Chronic defoliation by the western spruce budworm has aroused public concern in areas of high recreation value in the Carson and Lincoln National Forests. As one result of a court settlement, the Southwestern Region of the USDA Forest Service has set up an integrated pest management working group to help the Regional Forester develop improved practices for budworm management. The 12-member group brings a wide array of backgrounds and professions to focus on integrated pest management. The group includes leading authorities in entomological research, ecological pest management, ecology, silviculture, forest economics, environmental toxicology, sociology, and pest management administration. Members of the working group also represent the forest-products industry and environmentally concerned citizens in the private sector. Most serve voluntarily. As stated by the Regional Forester, "This is a prestigious group, whose members are leading authorities in their respective fields, that can assist us in reaching solutions to insect management problems in our forests."

The working group will conduct a comprehensive review on the Southwestern Region's forest pest management regulations, programs, and practices. They will review and issue recommendations on each aerial spray program involving chemical insecticides on the National Forests. They are also expected to initiate, design, and evaluate an integrated pest management demonstration area on an operational scale to show the feasibility of IPM methodology for management of the western spruce budworm in Southwestern forests.

Members of the working group are Tom Bible, Dave Brown, David Fellin, Sam Hitt, John Johnsen, Milo Larson, Jim Linnane, Johanna K. Major, Jim Matson, William Moir (chairperson, Brian R. Smith, and Ron Stark.

Will Moir — Ecologist, Range Management
USDA Forest Service, Region 3
Albuquerque, New Mexico

Trichogramma and the Spruce Budworm — An Update

The tactic of releasing large numbers of parasitoids to suppress agricultural insect pests has been used operationally for many years in the U.S.S.R., the People's Republic of China, and the Southern United States. Several Canadian scientists have learned about this technique and seen parasite production facilities while visiting China and the U.S.S.R. One of us (JRC) had the benefit of seeing a production unit for *Trichogramma* parasites in Leningrad in 1977; this was followed by visits to facilities in California and Texas, to learn more about production and release. At that time Mark Houseweart, University of Maine, was conducting field studies in Maine on inundative release of *Trichogramma minutum* (T.m.) against spruce budworm. Houseweart's work continued with good progress until 1982, when CANUSA support was discontinued.

In 1981, the Ontario Ministry of Natural Resources initiated a cooperative research project, involving OMNR, University of Guelph, University of Toronto and the Great Lakes Forest Research Centre (Canadian Forestry Service). (This project was referred to briefly in an article in the January 1984 CANUSA *Newsletter*). The Ontario project had three objectives:

1. To develop the technical capability to mass produce *Trichogramma minutum* (T.m.), a native parasite of spruce budworm, at the University of Guelph.
2. To determine the effect of various schedules and levels of release of T.m. on parasitism of spruce budworm eggs. This phase was carried out by University of Toronto, using ground releases. The effects of different environmental and rearing conditions were also investigated.
3. To develop methods for handling and aerial release of T.m. and determine the effectiveness of aerial releases. This phase was carried out by OMNR. Staff from GLFRC assisted in assessing the parasitism levels of budworm eggs in the area.

Production

OMNR is currently funding a 3.5-year project at the University of Guelph to develop the technology to mass rear T.m. (Funding continues until mid-1985). The initial attempts in 1982 and 1983, which used

Anagasta kuehilla as the host for T.m., were generally unsatisfactory. In 1983, the University of Guelph improved the rearing facility substantially, and changed to *Sitotroga cereallela* as the host insect. The result has been a dramatic increase in production capability. With this technology, the existing facility is now producing 120 million T.m. per month, but could produce over 300 million per month. As well, *Sitotroga* eggs can now be stored for as long as 60 days with no loss in quality.

Field Releases

a) *Ground Releases*

In 1982 and 1983, T.m. were released on the ground in a 20-year-old white spruce/balsam fir stand near Hearst in northern Ontario. Populations of spruce budworm were high (> 200 egg masses/9.29 m^2 [100 ft^2]) but natural T.m. parasitism was low (<4 percent of egg masses). Parasitism was monitored using a continuous supply of fresh, lab-reared budworm egg masses (sentinel egg masses) distributed randomly throughout the stand. In ground release trials, host eggs containing T.m. pupae was dispersed on a 7 metre (23 ft.) grid throughout the plots, 25 cm (10 in) above ground level. In 1982, the supply of T.m. was very low due to production difficulties, and the release density on the plots (0.25 ha [0.6 acre]) was only 480,000 female T.m./ha. This resulted in an average parasitism level of 16 percent. Release rates in 1983 were increased, and on plots receiving 12 million female T.m./ha., parasitism of *sentinel* budworm egg masses averaged 87 percent. At this release rate, 80 percent of the eggs within each egg mass were parasitized.

The 1983 releases also resulted in large increases in parasitism of *natural* egg masses. On white spruce, 41 percent of the egg masses were parasitized, and on balsam fir 64 percent were parasitized. In about 60 percent of the egg masses, over 75 percent of the eggs were parasitized. In untreated plots, parasitism was less than 1 percent. This reduction was also apparent in larval populations, sampled the following winter. The density of second instar larvae in these release plots was 80 percent lower than in untreated plots.

(b) *Aerial Releases*

OMNR has developed a system for aerial dispersal, which uses a modified small grains planter and an aerial seeding mechanism fitted to a Bell helicopter. Aerial releases were carried out in 1982 and 1983 in the same general area as the ground releases. Insufficient T.m. were produced in 1982 to permit a meaningful test of parasitism. In 1983, one aerial release was carried out, timed for the middle of the budworm oviposition period. T.m. were released at the rate of 15 million females/ha in a 2-hectare (5 acre) plot. Parasitism rates of 22 percent on spruce and 28 percent on fir were observed in the release area, compared with less than 1 percent in untreated areas. Furthermore, in 55 percent of the natural egg masses, over 75 percent of the eggs were parasitized.

With the conversion of the Guelph production facility to *Sitotroga* in 1983, production during 1984 was much greater and more reliable. Two aerial releases were completed 7 days apart on three 1-ha (2.5 acre) plots during the period of oviposition, at a release rate of 15 million female T.m./ha per release. Monitoring of these aerial releases showed that over 80 percent of the natural spruce budworm egg masses were parasitized, with over 75 percent of the eggs in each mass attacked. This 3-year program has been successful in achieving its three objectives. The technology to mass produce T.m. in Ontario has been developed to the point where large scale production is possible in Canada. Obviously, inundative releases of T.m. *can* achieve high levels of parasitism of spruce budworm eggs (> 50 percent), and helicopters can be used to efficiently deliver large numbers of T.m. over forest stands. What is needed next is an evaluation of the impact of various levels of egg parasitism on budworm population dynamics, and on defoliation of spruce and fir in the following year.

J. R. Carrow, S. A. Nicholson, B. H. McGauley — New Brunswick Department of Natural Resources Fredericton, N.B.

Green Notebooks Available

Dan Kucera, of State and Private Forestry in Broomall, has asked us to notify readers that a supply of green CANUSA three-ring binders is available from his office. The Program had these binders made to hold your collection of CANUSA's USDA series publications in the small Agriculture Handbook format.

If you would like a three-ring binder, write to

Publications
USDA Forest Service
Northeastern Area, State and Private Forestry
370 Reed Road
Broomall, PA 19008

Errata

We erred in identifying the smiling gentleman in the photo on the first page of the July issue of the *Newsletter*. The photo shows Al Gordon from Great Lakes Forest Research Centre not Gordon Stairs as the caption states. Although Gordon Stairs is an old friend and classmate of Al Gordon, Gordon was not present at that meeting. We are sorry for the mixup, fellas.

Out and About

October brought out a flush of CANUSA handbooks. The western component's first manuscript, "How To Separate Old and New Egg Masses of the Western Spruce Budworm" (A.H. 623), was released for distribution around the middle of the month. One week later, copies of Dick Reardon's "How To Protect Individual Trees from Western Spruce Budworm by Implants and Injections" (A.H. 625) and its companion piece, Larry Stipe's "Ground-Spray Techniques To Reduce Damage from Western Spruce Budworm (A.H. 624), appeared in Portland for distribution.

The same week saw Bob Marty's "Guide to Economic Evaluation of Spruce Budworm Management Opportunities in the East" (A.H. 627) head up to Broomall for distribution.

As the rest of CANUSA's USDA series publications are printed, we will announce them in the *Spruce Budworms Information Digest*, which all regular readers of this *Newsletter* will automatically receive.

Remember these two addresses for ordering individual copies of our books: For handbooks from CANUSA-East, write
Publications
USDA Forest Service
Northeastern Forest Experiment Station
370 Reed Road
Broomall, PA 19008
For handbooks from CANUSA-West, write
Publications
USDA Forest Service
Pacific Northwest Forest and Range Experiment Station
P.O. Box 3890
Portland, OR 97208

Items from the Press

Tiny worm eating away at North Woods. — Forest experts on both sides of the US-Canadian border are trying to outfox a tiny but obstinate caterpillar that has an apparently uncontrollable appetite.

In Maine, the budworm outbreak has invaded about 7.5 million acres of forest since 1976, when forestry experts began monitoring its effects. Budworms are reported to have stripped bare about 15 million cords of spruce and fir trees—roughly equivalent to five years' lumber harvest for the entire state of Maine, experts say.

"The problem is that the acreages are so vast and the kill so complete that there is nothing left," says Chuck Buckner of the Canadian Forest Service. "It will take 40 to 60 years to bring those pieces of acreage back again."

The last major budworm outbreak in the East started in 1912 and lasted approximately 10 years, until the budworms had literally eaten themselves out of house and home. The population gradually died off, and spruce trees began to grow again.

Now, 70 years later, forest experts are saying that the forest products industry—Maine's largest industrial moneymaker and employer—can't afford to let nature take its course again. Roughly 29 percent of all manufacturing jobs in Maine are related to the lumber industry, according to government statistics. The industry is dependent on a guaranteed supply of spruce and fir. [Budworm-caused shortages in the future] could necessitate production cutbacks, mill closures, and layoffs as early as 1995, according to some projections.

The Christian Science Monitor
October 1, 1984

N.B. This article was the result of interviews between reporter Warren Richey and Chuck Buckner and Mel McKnight, which took place during the Bangor symposium.

Maine faces timber shortage by 2000. — Maine, the most heavily forested state in the U.S., is facing a serious shortage of timber by the year 2000. Such a shortage could have a major impact on its economy, experts say.

Kenneth Stratton, director of the Maine Forest Service, estimated that by the end of the century the state would be about 20 percent short of its needs in spruce and fir, the most valuable woods for Maine's paper and sawmill industries.

Other studies done for the state government estimate that by the year 2020 less than 5 percent of Maine's forest will have trees suitable for industrial use.

The shortage, the experts agree, has been caused by a combination of factors: a serious infestation of spruce budworm, which has killed large tracts of trees; the fact that much of Maine's spruce and fir softwood forest is coming to maturity at the same time, and a rapid expansion of the paper business in the 1960s and 1970s.

"It is a very serious situation," said Stratton. "Some people are going to be hurt."

"But this isn't doomsday," he added. 'We can get a new forest after 2020 if we act in time."

Among the steps he recommends are making better use of the tops and branches of the spruce and fir trees that are now left to rot, and better forest management to speed up the growth of new spruce and fir trees.

The real question, concluded Gordon Baskerville, a professor of forestry at the University of New Brunswick, Canada, is whether Maine's timber industry executives will be farsighted enough to make costly investments now so there will be a new forest after 2020.

(The Citizen — October 27, 1984)
Ottawa, Ontario

Merrithew. — Prime Minister Mulroney looked east instead of west for his first forestry minister, but Gerry Merrithew of New Brunswick says he has a firm grasp on the industry's problems from coast to coast.

Merrithew, one of 39 cabinet ministers announced by Mulroney recently, left the New Brunswick legislature after 12 years to run in the federal election. He says forestry is the No. 1 industry in his home province as well as in British Columbia and he looks forward to running the new ministry.

He reminded reporters that as minister of natural resources in New Brunswick since 1982 he has been responsible for the province's forests.

He also sat on the board of directors of the Crown agency Forest Protection Ltd., which administers the province's controversial spraying program against spruce budworm.

(Daily Gleaner — September 18, 1984)
Fredericton, New Brunswick

Recent Publications

The following report and article have been published recently and may be of interest to budworm scientists.

From the Forest Pest Management Institute, Box 490, Sault Ste. Marie, Ont. P6A 5M7 you may request a copy of

Cadogan, B. L., B. F. Zylstra, P. de Groot and C. Nystrom. "The efficacy of aerially applied Matacil® to control spruce budworm *Choristoneura fumiferana* (Clem.) in Bathurst, New Brunswick." Information Report FPM-X-64.

And from the Maritimes Forest Research Centre, P.O. Box 4000, Fredericton, N.B. E3B 5P7, reprints are available of

MacLean, David A. "Effects of spruce budworm outbreaks on the productivity and stability of balsam fir forests." The Forestry Chronicle, October 1984, pp. 273-279.

The Canadian Forestry Service has released the proceedings of the final meeting of the Damage Assessment Working Group that took place in October 1983 at Bangor, Maine. To get a copy of "Proceedings of the Damage Assessment Working Group CANUSA Spruce Budworms Program," write to Canadian Forestry Service, 11th floor Place Vincent Massey, Ottawa, Ont. K1A 1G5.

In the Hopper

Since our September issue went to press (mid-July), several handbooks have been published (see "Out and About") and others have moved forward in the production process; but no new ones have arrived.

The worst piece of news concerns "Managing the Spruce Budworm in Eastern North America," Ag. Handbook 620. The "eastern management manual" was turned over to the U.S. Government Printing Office (GPO) late in July, for letting of the printing contract. We were notified to expect shipment of the finished product on November 2. By mid-October, when the color proof had not arrived for checking, we suspected there was trouble brewing. And on Halloween the cauldron boiled over. GPO admitted they had lost the book. Text, art, specifications sheet, printing and binding requisition—all gone.

Actually, what they admitted was that they had *found* the book. It had been "lost" within their plant since August 3. The printing contract had not been let; in fact, nothing at all had been done to get this book published.

We are disappointed to tell you that A.H. 620 will not be printed until December 31. Bulk shipments should reach Broomall, Pennsylvania, by the middle of January. And these dates hold only if the printers make good color proofs the first time.

Gary Fowler and Gary Simmons's "Sampling Procedures for Spruce Budworm Egg-Mass Surveys" (A.H. 635) is in galley proof. So is Ag. Handbook 636, "Guide to Hazard Rating Spruce-Fir Stands in the Lake States and Maine," by Witter and Lynch.

"Balsam Fir: Its Properties and Utilization" is in blueline proof, the final stage for a black-and-white book, and it should be out before Thanksgiving. That is Steve Sinclair's magnum opus; ask for Ag. Handbook 629.

Dave Tilles and Norman Woodley's parasites manual ("Spruce Budworm Parasites in Maine: A Reference Manual for Collection and Identification of Species," A.H. 616) is in exactly the same stage.

The western management manuals are crawling forward. Book one, "Western Spruce Budworm" (Tech. Bull. 1694), went out for typesetting November 1, which suggests we should have a book by next June. Book two, "Managing Trees and Stands Susceptible to Western Spruce Budworm" (Tech. Bull. 1695) went out for type a couple of days earlier. However, because it is a black-and-white book, Tech. Bull. 1695 should come out sooner, perhaps by April.

Management manual three, "Western Spruce Budworm and Forest-Management Planning," is stopped in its tracks while a chapter on environmental law is being revised with the help of USDA's Office of General Counsel. That chapter struck one Washington Office Staff reviewer as controversial, so CANUSA submitted the whole text to a second legal review. (OGC attorneys in the field had already cleared the manuscript.)

The entire package for book three has been ready for production since September 7 but cannot be submitted until Program Management in the West responds to the suggestions of the Washington Office legal staff. This process will take all of November at the very least. It is not possible now to predict exactly when book three will see print, but summer 1985 would be the earliest.

Bill Kemp's "Climatic Characteristics Associated with Occurrence and Duration of Western Spruce Budworm Outbreaks" (Tech. Bull. 1693) went out for type just before Halloween. This manuscript came in from the field in especially good shape, whizzed through Washington Office Staff review in September, and should reach print by early 1985.

Steve Shattuck's "Illustrated Key to Ants Associated with Western Spruce Budworm" (A.H. 632) is another summer-submitted manuscript that is progressing quickly through review and production. Layout was approved in mid-November, so the text will be printed during the winter.

News about other individual titles in the USDA series from CANUSA will appear in upcoming issues of the new publication that will succeed this *Newsletter*.

To get more information after termination of the CANUSA Program, contact

Canada-United States Spruce Budworms Program
USDA Forest Service
P.O. Box 2417, RPE-1211
Washington, DC 20013

Canada-United States Spruce Budworms Program
Canadian Forestry Service
19th Floor, Vincent Massey
Ottawa, Ont. K1A 1G5